Strata Formation and Preservation on the Eel River Shelf

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LONG-TERM GOALS

The long-term objective of this research is to investigate the processes influencing the emplacement and modification of strata on the continental shelf. This research is a part of the STRATAFORM research program. A primary goal is to identify the modern processes that form strata and to track the modification and ultimate destruction or preservation of such layers into the geologic record.

OBJECTIVES

The research objectives of this project include:

1) to identify the effects of major flood, storm, and earthquake events on the sedimentology and stratigraphy of the continental shelf by sampling the shelf immediately after events,

2) to investigate the relative contributions of post-depositional modifications of these event layers and to evaluate the potential of these deposits to be preserved into the geologic record, and

3) to use data from the upper few meters of the seabed to examine the along- and across-shelf variability of event layer character and preservation as applied over decadal to thousand-year time scales.

APPROACH

The Eel River shelf of northern California is the selected study site. The approach is to sample the shelf immediately after important environmental events and at closely spaced intervals thereafter, using a variety of techniques to monitor the changing character and distribution of event layers.

RESULTS

During the past year, cores were collected on two STRATAFORM cruises: on the *R/V Point Sur* in March 1998 and on the *R/V Wecoma* in July 1998. Box and piston cores were collected in March; Bothner slow-cores, box cores and vibracores were collected in July. In addition, side-scan sonar profiles were collected by N. Driscoll (WHOI) in July on the *R/V Wecoma* and in September on the *R/V Coral Sea*. Some of the samples collected in March and July have been analyzed. The September data has only been briefly examined thus far. Some of the results are highlighted below:

Eel River discharge events continue to result in the deposition of muds on the inner and middle shelf. In

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the initial year of study, an event bed was deposited on the continental shelf associated with the 1995 flood of the Eel River. The riverine sediments were carried to the north by shelf currents that occurred during the flood. Sediment analyses indicate that the flood sediments had high porosity (70-80%) and a median diameter of 8-16 microns on the central shelf. A second major flood occurred in 1997. The riverine sediments were once again carried northward and had high porosity and a median diameter of 8-16 microns on the central shelf.

During this past year, the Eel River discharge was characterized by a series of moderate flood events from January through March of 1998. Associated with the last of these discharge events, we were able to collect box cores both just prior to and just after the discharge event. A new surface mud layer (median diameter, 8-20 microns) up to 2 cm thick was sampled on the inner shelf in to water depths of 30 and 40 meters. In order to examine the longevity of these deposits on the inner shelf, cores were collected again in July. These cores revealed that mud layers remained at water depths of 20, 30 and 40 meters in some locations. At these sites, a surface sand layer up to 9 cm thick (median diameters 60-150 microns), covered the muds. In some of the cores, additional mud layers were encountered deeper in the cores suggesting their association with earlier discharge events. Preliminary results indicate that the thickness and frequency of muddy layers increases in deeper water and that they occur primarily to the north of the Eel River mouth.

As is indicated above, the effect of flood events on the Eel River shelf has been documented by rapid response to discharge in 1995, 1997 and 1998. The effect of storm waves was examined on cruises that were conducted in rapid response to storms that occurred in November and December 1995, when waves were recorded of height 6 m, period 17 s and height 9.5 m, period 17 s, respectively. At 50 meters water depth following the December 1995 storm, the sediment surface appeared to have been remobilized or buried. No identifiable remains of flood deposits that were sampled in November were encountered in box cores collected immediately after the December event. At 55 m, core surfaces were apparently mobilized during both the November and December storms as the thickness of flood layers decreased, core surface sediments coarsened, and clay contents decreased, but some recognizable flood material remained at 3-7 cm depth in the cores into the summer of 1996. From 60-65 m depth, some surface sediments were removed as the thickness of the flood layer decreased, surface sediments coarsened and clay contents decreased.

The effect of earthquakes on the shelf has not yet been documented in detail. However in July of 1998, side-scan sonar records indicated what appeared to be a slope failure on the shelf to the south of the Eel River mouth, at a depth of 50-51 meters. Slow-cores were subsequently collected within (depth, 51 m) and just outside of (depth, 49 m) the failure. Outside the failure, the sediments were fine sands with porosity of 35-40 %, with some thin mud layers from 12-18 cm depth in the core. The core is fairly typical for this water depth. Within the failure, significantly higher sediment porosity (65-75%) were encountered at 14-40 cm depth in the cores. The high porosity zone also contained higher mud concentrations. The high porosity values within the failure are suggestive that the failure occurred relatively recently and has not had the opportunity to fully dewater following the event. The Eel River margin is characterized by high seismicity. One expected effect of such seismicity would be slope failure in nearshore sands. The initial results are consistent with such an origin for the failure identified south of the Eel River mouth. We will resample this feature on subsequent cruises to track its modification with time.

SCIENTIFIC IMPACT

During the first four years of the STRATAFORM research program, my coworkers and I have had the unique opportunity to closely monitor the evolution of event layers on the Eel River shelf. The resulting data set will represent a significant contribution to understanding the transitions that event layers make in route to preservation in the stratigraphic record. These results, moreover, will elucidate the spatial and temporal variability of event-layer character and preservation, and will help in interpretation of high-frequency seismic and side-scan sonar records.

PUBLICATIONS

Borgeld, J.C., Hughes Clarke, J.E., Goff, J.A., Mayer. L.A. and Curtis, J.A. (in press) Acoustic backscatter of the 1995 flood deposit on the Eel shelf: *Marine Geology*.

Drake, D.E., Borgeld, J.C., Wheatcroft, R.A. 1998. Deposition and Modification of Flood and Storm Layers on the Eel Shelf, Northern California. *EOS*. Abstracts with Programs.